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PATENT SPECIFICATION

NO DRAWINGS

907,348

Date of filing Complete Specification: Sept. 30, 1960.

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COMPLETE SPECIFICATION

Improvements relating to the Reactivation of Nickel Catalysts

ERRATA

SPECIFICATION No. 907,348

Page 9, line 13, *after* "process" *insert* "variables has been reached, the reactivation treatment allows the process"

Page 10, line 26, *after* "(ASTM)" *insert* "min"

Page 10, line 26, *after* >720 *delete* "min"

THE PATENT OFFICE
3rd April 1964

2[illegible] ... are known. The upper limit of temperature is usually 760° C. They are frequently operated in the presence of steam in which case they are conventionally referred to as steam cracking. The principal products are normally-gaseous unsaturated hydrocarbons, but some gasoline is also produced, which is highly unsaturated and tends to form gum, possibly due to the presence of styrene, cyclopentadiene and other conjugated dienes. The gasoline also contains from 0.005 to 0.04% wt, of sulphur, but, because of the high temperature of the cracking this sulphur is thiophene sulphur rather than mercaptan sulphur. Because of this fact it has been recently found that the gasolines can be selectively hydrogenated to remove gum-forming compounds without appreciable hydrogenation of the high octane number mono-olefins and/or aromatics with a metallic nickel catalyst, which has been normally regarded as sulphur-sensitive. The process operates at temperatures below 200° C. and long on stream times of six months or more are possible during which the catalyst remains pre- without a previous catalyst oxidation step.

The gasolines may boil within the range 0—200° C., and preferably within the range 35—200° C.

The nickel catalyst is carried on a suitable inert support for example, activated alumina, a Group II metal carbonate such as calcium carbonate, sepiolite (as claimed in U.K. Patent Application No. 24027/58 (Serial No. 899,652)) or any other base which has a low activity for cracking reactions and a low activity for polymerisation reactions. Other examples of such low-activity bases are calcium, barium, strontium, or magnesium oxides, diatomaceous earths, fire brick derived from diatomaceous earth, silicon carbide, quartz, carbon (for example charcoal and graphite), pumice and deactivated alumina. The supported catalyst may contain from 1.0 to 50% of nickel, expressed as elemental nickel by weight of total catalyst, preferably 5 to 15% wt.

The upper limit of temperature should obviously be below that at which damage to the catalyst or support may occur and may

[*Price 4s. 6d.*]

Price 25p

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COMPLETE SPECIFICATION

Improvements relating to the Reactivation of Nickel Catalysts and use thereof in a Selective Hydrogenation process

We, THE BRITISH PETROLEUM COMPANY LIMITED, of Britannic House, Finsbury Circus, London, E.C.2, a British joint-stock Corporation, and PETER THOMAS WHITE and MARTIN FREDERICK OLIVE, both of the Company's Research Centre, Chertsey Road, Sunbury-on Thames, Middlesex, and both of British nationality, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the reactivation of metallic nickel catalysts used for the selective hydrogenation of gasolines obtained from thermal cracking processes operated at temperatures above 593° C.

Processes for the thermal cracking of petroleum hydrocarbons, for example straight run naphthas, at temperatures above 593° C. are known. The upper limit of temperature is usually 760° C. They are frequently operated in the presence of steam in which case they are conventionally referred to as steam cracking. The principal products are normally-gaseous unsaturated hydrocarbons, but some gasoline is also produced, which is highly unsaturated and tends to form gum, possibly due to the presence of styrene, cyclopentadiene and other conjugated dienes. The gasoline also contains from 0.005 to 0.04% wt, of sulphur, but, because of the high temperature of the cracking this sulphur is thiophene sulphur rather than mercaptan sulphur. Because of this fact it has been recently found that the gasolines can be selectively hydrogenated to remove gum-forming compounds without appreciable hydrogenation of the high octane number mono-olefins and/or aromatics with a metallic nickel catalyst, which has been normally regarded as sulphur-sensitive. The process operates at temperatures below 200° C. and long on stream times of six months or more are possible during which the catalyst remains predominantly but not completely metallic nickel. However the catalyst activity gradually declines and is compensated for by altering one or more of the process conditions, usually by raising the temperature. The precise cause of the deactivation is not known, but a simple method of at least partially restoring the activity would further increase the value of the process.

According to the present invention a method of reactivating a supported nickel catalyst in which the nickel is predominantly metallic nickel, which has been used in a process for the selective hydrogenation of gasolines obtained from thermal cracking processes operated at temperatures above 593° C., and which has become at least partially deactivated for that use, comprises passing a stream of hydrogen containing gas over the catalyst at a temperature above 150° C., without a previous catalyst oxidation step.

The gasolines may boil within the range 0—200° C., and preferably within the range 35—200° C.

The nickel catalyst is carried on a suitable inert support for example, activated alumina, a Group II metal carbonate such as calcium carbonate, sepiolite (as claimed in U.K. Patent Application No. 24027/58 (Serial No. 899,652)) or any other base which has a low activity for cracking reactions and a low activity for polymerisation reactions. Other examples of such low-activity bases are calcium, barium, strontium, or magnesium oxides, diatomaceous earths, fire brick derived from diatomaceous earth, silicon carbide, quartz, carbon (for example charcoal and graphite), pumice and deactivated alumina. The supported catalyst may contain from 1.0 to 50% of nickel, expressed as elemental nickel by weight of total catalyst, preferably 5 to 15% wt.

The upper limit of temperature should obviously be below that at which damage to the catalyst or support may occur and may

conveniently be 600° C. Temperatures at the lower end of the range are preferred, a particularly convenient temperature range being 200—300° C. The time of the reactivation may be from 1 to 24 hours, shorter times being suitable at the higher temperatures. If reactivation is carried on for any length of time above that strictly necessary for reactivation, there will, however, be no deleterious effect on the catalyst. The hydrogen-containing gas may be pure hydrogen or hydrogen admixed with other gases which are inert to hydrogen and the catalyst and support, for example, nitrogen or lower-boiling normally-gaseous hydrocarbons such as are found in the exit gas from a catalytic reformer. The rate of flow of the hydrogen may be from 20 to 2,000 v/v/hr. (preferably 100—500 v/v/hr.). The pressure may range from 0—1,000 p.s.i.g., preferably 0—350 p.s.i.g.

The metallic nickel catalyst may be prepared initially in any convenient manner, for example by impregnating a suitable support with a solution of a nickel compound, usually a salt, or by intimately mixing a nickel compound with a support. The catalyst is then shaped if necessary into particles of a suitable size and form and the nickel compound is reduced to metallic nickel either directly or through an intermediate stage in which the nickel compound is first converted to nickel oxide.

In the selective hydrogenation process, the gasoline is passed together with a hydrogen-containing gas over a catalyst of metallic nickel, preferably on a support, under conditions such that the gum-forming tendency of the gasoline is reduced. The conditions are also preferably controlled so that hydrogenation of mono-olefins and aromatics does not exceed the minimum necessary to ensure the required improvement in gum forming tendency. Depending on the gasoline being treated the hydrogen consumption may be at least 60 SCF/B more particularly at least 120 SCF/B and it may be more than 150 SCF/B. The upper limit of hydrogen consumption will be determined by the undesirability of substantially reducing the octane number of the gasoline by unnecessary hydrogenation of mono-olefins and/or aromatics. In practice a hydrogen consumption of less than 250 SCF/B should be suitable. Preferably the research octane number (with 1.5 ml TEL/IG) of the gasoline product is not more than one octane number below the research octane number of the similarly leaded feedstock. Leaded research octane numbers are preferred as a basis for comparison since while there may be some slight drop in research octane numbers (clear) as between feed and product, this is offset by an increased lead response in the product. Suitable hydrogenation conditions may be:—

Temperature	0 to 200° C. (preferably 80 to 180° C.)
Pressure	0 to 1000 p.s.i.g. (preferably 200—500 p.s.i.g.)
Gas rate (recycle or once through)	300 to 2000 SCF of hydrogen/B
Space velocity	0.5 to 10 v/v/hr. (preferably about 2 v/v/hr.)

The treated gasoline may be stabilised to give a product of low C_4 content and may also be re-run to remove a small proportion, for example, 6% wt. or less, of heavy ends. Re-running at a maximum temperature of not more than 250° C., and preferably not more than 205° C. may be advisable, since high re-running temperatures can adversely effect gum stability.

The reactivation treatment may be conveniently carried out in situ in the reactor without the necessity of removing the catalyst from the reactor. If, however, the catalyst has to be removed, for example to clear a blockage, it has been found that the catalyst can be replaced and reactivated according to the invention. The present invention therefore includes a selective hydrogenation process which includes the steps of passing a gasoline obtained from a thermal cracking process operated at a temperature above 593° C. together with a hydrogen-containing gas over a supported metallic nickel catalyst, under conditions to reduce the gum-forming tendency of the gasoline, discontinuing the process when evidence of catalyst deactivation is apparent, reactivating the catalyst according to the present invention and recommencing the hydrogenation process. Since the hydrogenation process takes place in the presence of hydrogen it may, when removal of catalyst from the reactor is not necessary, merely be necessary to discontinue passage of the feedstock and to continue to pass hydrogen with any alteration of process conditions considered necessary. Evidence of catalyst deactivation is

supplied by a drop in hydrogen consumption under the process conditions used and, as stated earlier, is normally compensated for by altering one or more process variables to maintain the hydrogen consumption. Suitable alterations of the process variables include raising the hydrogen partial pressure, increasing the hydrogen/feedstock ratio, decreasing the feedstock flow rate or raising the temperature, the latter being preferred. The present reactivation treatment may be used in combination with such a process where catalyst deactivation is compensated for by alteration of process variables, since the reactivation treatment allows the process to be restarted under less severe conditions, even if the activity is not restored to that of a fresh catalyst.

The invention is illustrated by the following examples:—

EXAMPLE 1

A steam cracker gasoline having a boiling range of 45 to 200° C. was hydrogenated using a catalyst of 9.1 percent weight nickel on alumina under the following process conditions:—

Pressure	350 p.s.i.g.
Space Velocity	2.0 v/v/hr.
Gas Recycle Rate	500 SCF/B
Make up Gas	Platinum Reformer Exit Gas containing 70—80 per cent mol hydrogen

The initial temperature with fresh catalyst was 111° C. which gave a hydrogen consumption of 150 SCF/B and a re-run product having the following inspection data compared with the feedstock.

	Feedstock	Re-run Product
Gum Existent mg/100 ml	1	1
Gum Accelerated (120 min) mg/100 ml.	10	3
Induction Period (ASTM) min	435	560
Total sulphur % wt.	0.009	0.009
Octane number, Research, clear	92.3	90.8
Octane number, Research, + 1.5 ml TEL/IG	95.9	95.8

To maintain the hydrogen consumption and hence the quality of the product, the temperature was raised stepwise as follows:

Hours on Stream	70	190	670	2220	2550
Temperature °C.	127	143	152	166	204

After 2595 hours on stream, equivalent to 13.8 bbl of feedstock processed/lb of catalyst, the run was discontinued due to reactivation of the catalyst. The catalyst was reactivated by passing a stream of hydrogen through the reactor under the following conditions:

Temperature	250° C. (482° F.)
Pressure	Atmospheric
Hydrogen flow rate	100 v/v/hr.
Time	4 Hours

The process was then restarted under the conditions stated above, when it was found that the same hydrogen consumption and product quality could be achieved at a temperature of 143° C. As the process continued the temperature was again raised stepwise as follows:

Hours on stream	307	477	690
Temperature °C.	160	166	204

The step of catalyst reactivation thus had the effect of increasing the hours on stream by 696, equivalent to an additional 3.6 barrels of feedstock processed per lb of catalyst.

EXAMPLE 2

A steam cracker gasoline having a boiling range of 45 to 200° C. was hydrogenated using a catalyst of 9.45% wt. nickel on sepiolite under the following process conditions:

Pressure	350 p.s.i.g.
Space Velocity	2 v/v/hr.
Gas Recycle Rate	500 SCF/B
Make up Gas	Platinum reformer Exit Gas containing 70—80% mol of H_2

The initial temperature with fresh catalyst was 118° C. which gave a hydrogen consumption of 150 SCF/B and a rerun product having the following inspection data compared with the feedstock.

	Feedstock	Re-run Product
Gum Existent mg/100 ml	1	1
Gum accelerated (120 min) mg/100 ml	10	5
Induction Period (ASTM) min	435	720
Total sulphur % wt.	0.009	0.008
Octane number, Research, clear	92.3	91.0
Octane number, Research, + 1.5 ml TEL/IG	95.9	95.9

To maintain the hydrogen consumption and hence the quality of the product, the temperature was raised stepwise as follows:

Hours on stream	335	703	924	3250
Temperature °C.	127	135	152	154

After 4934 hours on stream (equivalent to at least 43 bbl of feedstock processed/lb of catalyst), the process was discontinued and after purging of residual feedstock and hydrogen from the reactor, the catalyst was removed to clear a blockage and replaced. The catalyst was then reactivated by passing a stream of hydrogen through the reactor under the following conditions:

Temperature	250° C. (482° F.)
Pressure	Atmospheric
Hydrogen flow rate	100 v/v/hr.
Time	4 hours

The process was then restarted under the conditions set out above when it was found that the same hydrogen consumption and product quality could be achieved at a temperature of 127° C. As the process continued the temperature was again raised stepwise as follows:

Hours on stream	127	661	700
Temperature °C.	138	143	149

The step of catalyst reactivation had the effect of increasing the hours on stream by at least 1300 hours equivalent to an additional 8.0 barrels of feedstock processed/lb of catalyst. In addition the example shows that the reactivation treatment effectively counteracts any alteration in the catalyst which may take place when it is exposed to atmosphere during removal and replacement.

EXAMPLE 3

A steam cracker gasoline having a boiling range of 48 to 200° C. was hydrogenated using a catalyst of 10 per cent wt. nickel on sepiolite under the following process conditions:

Pressure	350 p.s.i.g.
Space Velocity	2 v/v/hr.
Gas Recycle Rate	500 SCF/B
Make up Gas	Platinum reformer gas containing ca 70% mol hydrogen

The initial temperature was 114° C. which gave a hydrogen consumption of 140 SCF/B and a re-run product having the following inspection data compared with the feedstock:

	Feedstock	Product
Gum existent mg/100 ml	8	2
Gum accelerated (120 min) mg/100 ml	41	14
Induction Period (ASTM) min.	310	705
Total sulphur % wt.	0.039	0.023
Octane number, Research, clear	97.4	97.6
Octane number, Research, + 1.5 ml TEL/IG	99.2	99.2

To maintain the hydrogen consumption and hence the product quality, the catalyst temperature was raised as follows:

Hours on stream	130	210	327
Temperature °C.	121	132	160

After 397 hours on stream the run was stopped and after purging the catalyst of residual feedstock, reactivation was carried out by passing a stream of platinum reformer gas containing ca 70% hydrogen through the reactor under the following conditions:

Catalyst Temperature	204° C. (400° F.)
Pressure	350 p.s.i.g.
Activating gas flowrate	175 vol (gas at STP)/vol catalyst hr.
Time	4 hours

The process was then restarted when it was found that the same hydrogen consumption and product quality could be achieved at a temperature of 138° C. compared with 160° C. immediately before the reactivation. As the run continued the temperature was again raised stepwise as follows:

Hours on stream	1410	1500
Temperature °C.	142	149

Thus the catalyst temperature 1100 hours after reactivation was still lower than the catalyst temperature before reactivation.

WHAT WE CLAIM IS:—

1. A method of reactivating a supported nickel catalyst in which the nickel is predominantly metallic nickel, which has been used in a process for the selective hydrogenation of gasolines obtained from thermal cracking processes operated at temperatures above 593° C., and which has become at least partially deactivated for that use, comprising

passing a stream of hydrogen containing gas over the catalyst at a temperature above 150° C., without a previous catalyst oxidation step.

2. A method as claimed in claim 1 wherein the reactivation temperature is from 150 to 600° C.

3. A method as claimed in claim 2 wherein the reactivation temperature is from 200 to 300° C.

4. A method as claimed in claims 1, 2 or 3 wherein the time of the reactivation is from 1 to 24 hours.

5. A method as claimed in any of claims 1 to 4 wherein the rate of flow of hydrogen during reactivation is from 20 to 2000 v/v/hr.

6. A method as claimed in any of claims 1 to 5 wherein the pressure during reactivation is from 0 to 1000 p.s.i.g.

7. A method as claimed in any of claims 1 to 6 wherein the catalyst has from 1.0 to 50% wt. of nickel, expressed as elemental nickel.

8. A selective hydrogenation process which includes the steps of passing a gasoline obtained from a thermal cracking process operated at a temperature above 593° C. together with a hydrogen-containing gas over a supported metallic nickel catalyst under conditions to reduce the gum-forming tendency of the gasoline, discontinuing the process when evidence of catalyst deactivation is apparent, reactivating the catalyst by a method as claimed in any of claims 1 to 7, and recommencing the hydrogenation process.

9. A selective hydrogenation process as claimed in claim 8 wherein the temperature of the selective hydrogenation is from 0 to 200° C.

10. A selective hydrogenation process as claimed in claim 9 wherein the temperature is from 80 to 180° C.

11. A selective hydrogenation process as claimed in claim 8, 9 or 10 wherein the selective hydrogenation is carried out at a pressure of from 0 to 1000 p.s.i.g., a space velocity of from 0.5 to 10 v/v/hr and a gas rate of from 300 to 2000 SCF of hydrogen/B.

12. A selective hydrogenation process as claimed in any of claims 8 to 11 wherein the hydrogen consumption during the selective hydrogenation is from 60 to 250 SCF/B.

13. A selective hydrogenation process as claimed in any of claims 8 to 12 wherein the Research octane number (with 1.5 ml. TEL/IG) is not more than one octane number below the Research octane number of the similarly leaded feedstock.

14. A selective hydrogenation process as claimed in any of claims 8 to 13 wherein the temperature is raised during the hydrogenation to maintain the hydrogen consumption.

15. A selective hydrogenation process as claimed in claim 14 wherein the hydrogenation is recommenced at a lower temperature than that at which it was discontinued.

16. A method as claimed in claim 1 substantially as described in the Examples.

17. A selective hydrogenation process as claimed in claim 8 substantially as described in the Examples.

J. WOOLARD,
Agent for the Applicants,
Chartered Patent Agent.

PROVISIONAL SPECIFICATION

Improvements relating to the Reactivation of Nickel Catalysts and use thereof in a Selective Hydrogenation process

We, THE BRITISH PETROLEUM COMPANY LIMITED, of Britannic House, Finsbury Circus, London, E.C.2, a British joint-stock Corporation, and PETER THOMAS WHITE and MARTIN FREDERICK OLIVE, both of the Company's Research Centre, Chertsey Road, Sunbury-on Thames, Middlesex, and both of British nationality, do hereby declare this invention to be described in the following statement:—

This invention relates to the reactivation of nickel catalysts used in hydrogenation processes.

Catalysts of reduced nickel are known to have hydrogenating properties and have been used or proposed for various hydrogenation processes. The nickel may be carried on a support. During the hydrogenation process the catalyst may lose activity, and it is desirable, in order to give the maximum catalyst life, to be able to restore at least a portion of the lost activity.

According to the present invention, a catalyst of reduced nickel, preferably on a support, which has lost activity in a hydrogenation process, is reactivated by treatment with a stream of hydrogen-containing gas at a temperature above 150° C.

The upper limit of temperature should obviously be below that at which damage to the catalyst or support may occur and may conveniently be of the order of 600° C. Temperatures at the lower end of the range are preferred, a particularly convenient temperature range being 200—300° C. The time of the reactivation may be from 1 to 24 hours, shorter times being suitable at the higher temperatures. If reactivation is carried on for any length of time above that strictly necessary for reactivation, there will, however, be no deleterious effect on the catalyst. The hydrogen-containing gas may be pure hydrogen or hydrogen admixed with other gases which are inert to hydrogen and the catalyst and support, for example nitrogen or lower-boiling hydrocarbons such as are found in the exit gas from a catalytic reformer. The rate

of flow of the gas may be from 20 to 2,000 v/v/hr. (preferably 100 v/v/hr.). The pressure may range from 0—200 psig, atmospheric pressure being preferred. The reactivation treatment may be applied to a catalyst used in any hydrogenation process, but it is particularly suitable for the reactivation of catalysts used for the controlled hydrogenation of steam cracker gasoline, which is herein defined as a gasoline produced by cracking a petroleum distillate in the presence of steam. Such cracked gasoline is highly unsaturated and tends to form gum possibly due to the presence of styrene, cyclopentadiene and other conjugated dienes. In this process, the steam cracker gasoline is passed together with a hydrogen-containing gas over a catalyst of nickel deposited on a support under conditions such that the gum-forming tendency of the gasoline is reduced. The conditions are also preferably controlled so that hydrogenation of mono-olefins and aromatics does not exceed the minimum necessary to ensure the required improvement in gum-forming tendency. Depending on the gasoline being treated the hydrogen consumption may be at least 60 SCF/B more particularly at least 120 SCF/B and it may be more than 150 SCF/B. The upper limit of hydrogen consumption will be determined by the undesirability of substantially reducing the octane number of the gasoline by unnecessary hydrogenation of mono-olefins and/or aromatics. In practice a hydrogen consumption of less than 250 SCF/B should be suitable. Preferably the research octane number (with 1.5 ml. TEL/IG) of the gasoline product is not more than one octane number below the research octane number of the similarly leaded feedstock. Leaded research octane numbers are preferred as a basis for comparison since while there may be some slight drop in research octane numbers (clear) as between feed and product, this is offset by an increased lead response in the product. Suitable hydrogenation conditions may be:—

Temperature	0 to 200° C. (preferably 80 to 180° C.)
Pressure	0 to 1000 psig (preferably 200—500 psig)
Gas recycle rate (recycle or once through)	300 to 1000 SCF of hydrogen/B
Space velocity	0.5 to 10 v/v/hr. (preferably about 2 v/v/hr.)

The treated gasoline may be stabilised to give a product of low C_4 content and may also be re-run to remove a small proportion, for example, 6% wt or less, of heavy ends. Re-running at a maximum temperature of not more than 250° C., and preferably not more than 205° C. may be advisable, since high re-running temperatures can adversely effect gum stability.

Other examples of hydrogenation processes using nickel catalysts, for which the present reactivation treatment may be suitable, are the conversion of mono-olefinic compounds to saturated compounds, the conversion of aromatic compounds to naphthenic compounds, the conversion of acetylenic compounds to olefinic or saturated compounds, particularly the selective conversion of acetylenic compounds to olefinic compounds in the presence of olefinic compounds without substantial saturation of the latter and the conversion of di-olefinic compounds to mono-olefinic or saturated compounds, particularly the selective conversion of di-olefinic compounds to mono-olefinic compounds in the presence of mono-olefinic compounds without substantial saturation of the latter.

The reactivation treatment may be conveniently carried out in situ in the reactor without the necessity of removing the catalyst from the reactor. If, however, the catalyst has to be removed, for exampie to clear a blockage, it has been found that the catalyst can be replaced and reactivated according to the invention. The present invention therefore includes a hydrogenation process which includes the steps of passing a feedstock together with a hydrogen-containing gas over a nickel catalyst, preferably on a support, under conditions at least partially to hydrogenate the feedstock, discontinuing the process when evidence of catalyst deactivation is apparent, reactivating the catalyst according to the present invention and recommencing the hydrogenation process. Since the hydrogenation process takes place in the presence of hydrogen it may, when removal of catalyst from the reactor is not necessary, merely be necessary to discontinue passage of the feedstock and to continue to pass hydrogen with any alteration of process conditions considered necessary. Evidence of catalyst deactivation is supplied by a drop in hydrogen consumption under the process conditions used and is

normally compensated for by altering one or more process variables to maintain the hydrogen consumption. Suitable alterations of the process variables include raising the hydrogen partial pressure, increasing the hydrogen/feedstock ratio, decreasing the feedstock flow rate or raising the temperature, the latter being preferred. The present reactivation treatment may be used in combination with such a process where catalyst deactivation is compensated for by alteration of process variables, since when the practical limit of compensation by alteration of process to be restarted under less severe conditions, even if the activity is not restored to that of a fresh catalyst.

The nickel catalyst may be deposited on any suitable support for example, activated alumina, a Group II metal carbonate such as calcium carbonate, sepiolite or any base which has a low activity for cracking reactions and a low activity for polymerisation reactions. Other examples of such low-activity bases are calcium, barium, strontium, or magnesium oxides, diatomaceous earths, fire brick derived from diatomaceous earth, silicon carbide, quartz, carbon (for example charcoal and graphite), pumice and deactivated alumina. The catalyst may contain from 1.0 to 50% of nickel, expressed as elemental nickel by weight of total catalyst, preferably 5 to 15% wt.

The invention is illustrated by the following examples:—

EXAMPLE 1

A steam cracker gasoline was hydrogenated using a catalyst of 9.1 per cent weight nickel on alumina under the following process conditions:

Pressure	350 psig
Space Velocity	2.0 v/v/hr.
Gas Recycle Rate	500 SCF/B
Make up Gas	Platformer Exit Gas containing 70—80 per cent mol hydrogen

The initial temperature with fresh catalyst was 111° C. which gave a hydrogen consumption of 150 SCF/B and a rerun product having the following inspection data compared with the feedstock.

	Feedstock	Rerun Product
Gum Existent mg/100 ml	1	1
Gum Accelerated (120 min) mg/100 ml.	10	3
Induction Period (ASTM) min	435	560

To maintain the hydrogen consumption and hence the quality of the product, the temperature was raised stepwise as follows:

Hours on Stream	70	190	670	2220	2550
Temperature °C.	127	143	152	166	204

After 2595 hours on stream, equivalent to 13.8 bbl of feedstock processed/lb of catalyst, the run was discontinued due to deactivation of the catalyst. The catalyst was reactivated by passing a stream of hydrogen through the reactor under the following conditions:

Temperature	250° C. (482° F.)
Pressure	Atmospheric
Hydrogen flow rate	100 v/v/hr.
Time	4 Hours

The process was then restarted under the conditions stated above, when it was found that the same hydrogen consumption and product quality could be achieved at a temperature of 143° C. As the process continued the temperature was again raised stepwise as follows:

Hours on stream	307	477	690
Temperature °C.	160	166	204

The step of catalyst reactivation thus had the effect of increasing the hours on stream by 696, equivalent to an additional 3.6 barrels of feedstock processed per lb of catalyst.

EXAMPLE 2

A steam cracker gasoline was hydrogenated using a catalyst of 9.45% wt nickel on sepiolite under the following process conditions:

Pressure	350 psig
Space velocity	2 v/v/hr.
Gas recycle rate	500 SCF/B
Make up Gas	Platformer Exit Gas containing 70—80% mol of H_2

The initial temperature with fresh catalyst was 118°C. which gave a hydrogen consumption of 150 SCF/B and a rerun product having the following inspection data compared with the feedstock.

	Feedstock	Rerun Product	
Gum Existent mg/100 ml	1	1	
Gum accelerated (120 min) mg/100 ml	10	5	
Induction Period (ASTM)	435	>720	min

To maintain the hydrogen consumption and hence the quality of the product, the temperature was raised stepwise as follows:

Hours on stream	335	703	924	3250
Temperature °C.	127	135	152	154

After 4934 hours on stream (equivalent to at least 43 bbl of feedstock processed/lb of catalyst), the process was discontinued and after purging of residual feedstock and hydrogen from the reactor, the catalyst was removed to clear a blockage and replaced. The catalyst was then reactivated by passing a stream of hydrogen through the reactor under the following conditions:

Temperature	250° C. (482° F.)
Pressure	Atmospheric
Hydrogen flow rate	100 v/v/hr.
Time	4 hrs.

The process was then restarted under the conditions set out above when it was found that the same hydrogen consumption and product quality could be achieved at a temperature of 127° C. As the process continued the temperature was again raised stepwise as follows:—

Hours on stream	127	661	700
Temperature °C.	138	143	149

The step of catalyst reactivation had the effect of increasing the hours on stream by at least 1300 hours equivalent to an additional 8.0 barrels of feedstock processed/lb of catalyst. In addition the example shows that the reactivation treatment effectively counteracts any alteration in the catalyst which may take place when it is exposed to atmosphere during removal and replacement.

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